

**BELT FORCE MEASURING DEVICE****CLAIM FOR PRIORITY**

This application claims priority to German Application No. DE  
5 102 43 344.5, filed September 18, 2002, in the German language,  
the contents of which are hereby incorporated by reference.

**TECHNICAL FIELD OF THE INVENTION**

The invention relates to a belt force measuring device for  
10 measuring a belt tension force acting on a seat belt buckle in  
a motor vehicle.

**BACKGROUND OF THE INVENTION**

In order to improve occupant protection in a car it is  
15 necessary to measure the belt force of a person who is strapped  
in. The data is processed and is used, for example, during an  
accident to calculate the optimum triggering of belt tensioners  
and airbags.

20 U.S. Patent No. 6,230,088 B1 discloses a seat belt buckle  
housing which is connected via a belt force measuring device to  
a fixing point affixed to the bodywork of a vehicle. The belt  
force measuring device comprises a first part which is linked  
25 to the seat belt buckle and on which a detector in the form of  
a magnet is located. Furthermore, a second part is provided  
which is linked to the fixing point. A sensor element in the  
form of a GMR sensor is located on the second part. The first  
and second parts are linked together via two springs, each of  
which is freely supported. The belt force results in a  
30 deformation of the spring elements, so that the distance  
between the detector and the sensor element changes, which is  
analyzed as a measurement signal for the belt force.

Such a belt force measuring device has the disadvantage that during operation of the vehicle the characteristic curve of the sensor is frequently displaced, i.e. a zero displacement occurs. Furthermore, the measurement signals also exhibit an  
5 undesired hysteresis.

#### SUMMARY OF THE INVENTION

The invention generally relates to a belt force measuring device which is simple and which during operation of the belt  
10 force measuring device is reliable and accurate.

Bearing points of a freely supported measuring spring of such a device can change slightly as a result of vibrations, position displacement or wear. In the prior art, this leads to the  
15 observed zero displacement. Furthermore, the invention is based on the knowledge that the hysteresis of the measurement signal of the belt force measuring device is caused by friction in supporting points and guide surfaces of the measuring spring in the prior art. The invention avoids this disadvantageous  
20 measurement by arranging a detector on the measuring spring rigidly to a first bearing of the measuring spring, and by arranging a sensor element rigidly on a second bearing of the measuring spring.

#### 25 BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention are explained in the following on the basis of the drawings. In the drawings:

Figure 1 shows a plan view of a belt force measuring device.  
30 Figure 2 shows a section through the belt force measuring device in accordance with Figure 1 along the line II,  
II'.

Figure 3 shows a measuring spring located in the belt force measuring device in accordance with Figure 1.

Elements having the same design and function bear the same reference characters in the figures.

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#### DETAILED DESCRIPTION OF THE INVENTION

A belt force measuring device (Figure 1) comprises a housing 1, into which a rivet 3 is inserted in a form-fit fashion. An anchor 5, which is affixed to the bodywork of the vehicle or 10 also to a seat in the vehicle, comprises a cable 7 which is linked to the rivet 3. A slit 9 is provided in the housing 1 to insert a mating component which is linked to a seat belt. Furthermore, a locking and unlocking apparatus is provided which locks and unlocks the mating component. The locking and 15 unlocking apparatus includes a latching part 13 which is preferably formed from plastic, and further includes a spring 15. The spring 15 is linked on one side to the latching part 13 and on the other side to a locking tab 17. The locking and unlocking apparatus is formed and arranged in this case such 20 that the flow of force takes place from the mating component in the locked state of the latching part 13 via the latching part 13 direct to the locking tab 17.

The locking tab 17 is mounted with play in the housing so that 25 it can move back and forth in parallel to the axis indicated by the double arrow 18. This axial play is selected so as to be preferably approximately in the range of 1 mm. The locking tab 17 is linked to a measuring spring 19. The measuring spring 19 is linked to the rivet 3 and thereby to the housing 1. The 30 force acting in the belt is thus transferred ultimately to the anchor 5 when the mating component is locked, via the latter and then the latching part 13, the locking tab 17, the measuring spring 19 and the rivet 3, so long as the force is

not yet so high that the locking tab 17 arrives at one of its stop points on the housing 1 in the context of its bearing provided with play. As soon as the contact tab arrives at one of its stop points, a part of the force is then transferred  
5 direct from the locking tab 17 via the housing 1 and the rivet 3 to the anchor 5.

The measuring spring has circular recesses 21, 23 which are linked via pivots 25, 27 to the locking tab 17. The circular  
10 recesses 21, 23 form together with the pivots 25, 27 a first bearing of the measuring spring. The measuring spring additionally has another circular recess 29, via which the measuring spring 19 is linked to the rivet 3. The circular recess 29 forms together with the rivet 3 a second bearing of  
15 the measuring spring 19. The measuring spring 19 additionally has recesses 31, 35 to accommodate a detector 33 and a sensor element 37. The detector 33 is fixed in the recess 31. The sensor element 37 is fixed in the recess 35. The detector is preferably in the form of a magnet. The sensor element is  
20 preferably in the form of a Hall element and also includes analysis electronics for the Hall element, which are preferably in the form of an ASIC.

The detector 33 is arranged rigidly to the first bearing of the  
25 measuring spring 19. The sensor element 37 is arranged rigidly to the second bearing of the measuring spring 19. The detector 33 and the sensor element 37 thus move in respect of one another in accordance with the respective expansion of the measuring spring 19. The measurement signal of the sensor  
30 element 37 is thus characteristic of the force acting on the measuring spring 19.

- Preferably the detector 33 and also the sensor element 37 are located on the measuring spring 19 so that they cannot rotate. This has the advantage that during operation of the belt force measuring device it is ensured that neither the detector 33 nor the sensor element 37 can rotate in relation to one another, which would result in a change in the characteristic curve of the measurement signal and thus to a measurement error. The arrangement, which cannot rotate, is then ensured in a particularly simple manner by a circular hole with a bulge, which is preferably square. However, it can also be ensured alternatively or additionally by an adhesive connection of the measuring spring 19 with the detector 23 or the sensor element 37.
- The spring constant of the measuring spring 19 is selected such that the force range to be measured, which for example is 0 to 150 newtons, can be recorded by the sensor element. This means that the deflection of the measuring spring in the event of the maximum force to be recorded should be such that the locking tab 17 has not yet reached its stop point at this force. If the force which is transferred from the belt increases above a value which exceeds the value which results in a deflection of the measuring spring 19, whereby the locking tab 17 abuts against its stop point, the force transferred via the measuring spring 19 remains constant even if the force increases further. As a result, it is ensured that the measuring spring 19 is not plastically deformed and thus can be used reliably and permanently.
- The first bearing of the measuring spring 19 is achieved via the circular recess 21, 23 and the pivots 25, 27 which are formed such that the bearing is achieved flexibly. As a result, it is ensured that no bending forces can be transferred from

the locking tab 17 to the measuring spring 19 and vice versa, which would lead to a relative movement between the detector 33 and the sensor element 37 and thus would corrupt the measurement signal.

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Preferably the second bearing, i.e. the link between the circular recess 29 and the rivet 3, is also formed flexibly, so that here too no bending forces can be transferred to the measuring spring 19 and thus corruption of the measurement  
10 signal is also prevented.

The measuring spring 19 is preferably formed in a simple manner as a spring steel strip. However, it can also be formed as a wire torsion spring with corresponding lugs for accommodating  
15 the detector and the sensor element.